Effects of Turning Frequency and Pile Size on the Composting of Dairy Manure

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INTRODUCTION

Composting offers the potential to significantly reduce problems associated with manure management including odors, pathogens, ground water pollution, and utilization costs. Composts can be sold into high value off-farm markets and have been shown to suppress common plant diseases (Hoitink et al.,1986). Windrow composting is the most commonly used method to prepare manure composts (Stentiford 1996). It consists of placing a mixture of raw materials in long narrow piles or windrows which are mechanically turned on a regular basis (Fig. 1). The costs for on-farm composting are strongly related to pile size (which affects pad costs) and equipment and labor costs for windrow turning. Overall objectives of our research are to determine optimal turning frequencies and pile sizes for manure composting to minimize these costs. In this study we examined the effects of two pile sizes and two turning frequencies on volatile solids loss, moisture content, oxygen and temperature gradients and bulk density on the composting of dairy manure with sawdust.

Figure 1: Tractor drawn windrow turner used for windrow turning. A loader was used to turn the larger piles.

MATERIALS AND METHODS

Compost pile and windrow formation Full scale compost treatments were set-up at the OARDC composting pad. The composts where made from similar initial mixtures of dairy manure and sawdust of approximately 3 parts manure to 1 part sawdust (wet basis). The windrows weighed 6-7 tons (data not shown).

Treatments Three different series (A, B, C) were built. Windows A and B were built with dimensions of 25ft x 3-4 ft x 10ft (length/width/height), with an estimated surface area of 23 ft^2 for each windrow. Pile C was a cone with dimensions of 10ft x 34 ft (height/radius). Window (A) was turned every three days, while the other window (B) and the pile (C) were turned once every 10 days.

Temperature and Oxygen profiles Pile and windrow temperatures were measured manually using a series of thermo-couples placed at different depths (5 cm, 60 cm and 120 cm). Oxygen concentrations were determined using a polaragraphic oxygen probe before turning and every 30 minutes after turning for a 120 minute period at similar depths.

Compost samples Samples (0.03 m^3) were also collected from three different depths (5 cm, 60 cm and 120 cm) before turning and a composite sample was collected immediately after turning.

Measurements The organic matter (volatile solids) content, bulk density and moisture content of compost samples were determined as described by Michel *et al. (*1993) and Michel et al. (1996).

ACKNOWLEDGMENTS & REFERENCES

• Special Thanks to OARDC Research Operations Farm Shop crew

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ABSTRACT

Two variables that directly affect on-farm composting costs are windrow size and windrow turning frequency. However the size of a windrow is limited by the depth of penetration of oxygen and high temperatures and occasional turning is necessary to mix the compost to assure even decomposition and pathogen destruction. In this study, one set of windrows (A) were turned using a self-propelled and tractor drawn windrow turner every three days for a total of 30 turns during 16 weeks. A second set (B) were turned once every 10 days. A third set (C) consisted of much larger piles turned every 10 days. Windows were divided into three replicates with an approximate dimension of 25ft length, 3-4ft height and 10ft width, and an estimated surface area of 23ft^2 . Oxygen and temperature profiles were measured before turning at three depths as well as every 30 minutes thereafter to determine the duration of the effect of turning and to estimate oxygen demand as a function of compost age. Results will be useful in establishing more guidelines for efficient dairy manure compost production.

Table 1: Experimental Treatments used in this study.

#	Description	Turning Frequency	Surface Area to Volume Ratio (ft^3/ft^2)
A	Frequently turned Windrow	Every 3 days	0.55
B	Infrequently turned Windrow	Every 10 days	0.51
C	Infrequently turned Large Pile	Every 10 days	0.31

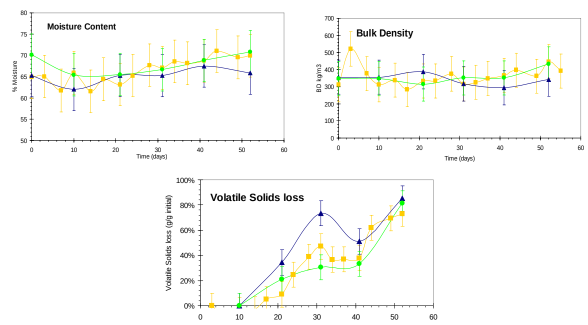

Figure 2. Averages of physical properties in treatments

A Window (1turn/3d) B Window (1turn/10d) C Pile (1turn/10d)

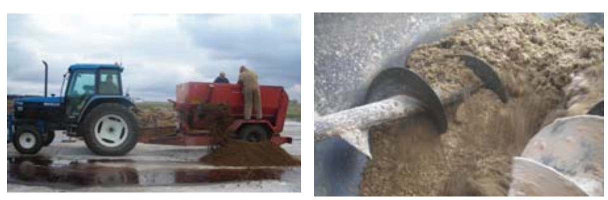

Figure 3: Mixing, weighing and building compost piles (day 0).

RESULTS

Three treatments were composted during the winter of 2007 throughout a period of cold and wet weather during which average daily air temperatures were 24$\pm$11 ^oF and 4.9 inches of precipitation was recorded. The initial moisture contents of the composts were 65-70% (Fig. 3). The moisture contents rose similarly in all three treatments to approximately 75% after 60 days. Bulk density maintained a nearly constant range of from 300-400 kg/m^3 in all three treatments. Volatile solids losses, calculated assuming constant ash, reached similar levels regardless of turning frequency or pile size (Fig. 2). Turning had only a transitory effect on compost oxygen concentrations. After turning, oxygen concentrations increased (Fig 4). However after 2 hours oxygen concentrations were similar to levels before turning at both 60 cm and 120 cm depths. Compost temperatures at the center (120 cm) rose to greater than 55˚C after 10 days in all three treatments. At depths closer to the surface, (5 and 60 cm) temperatures were lower and appeared to be influenced by turning frequency but not pile size (Fig. 5). Temperatures at these levels were highest in the infrequently turned windrows (B).

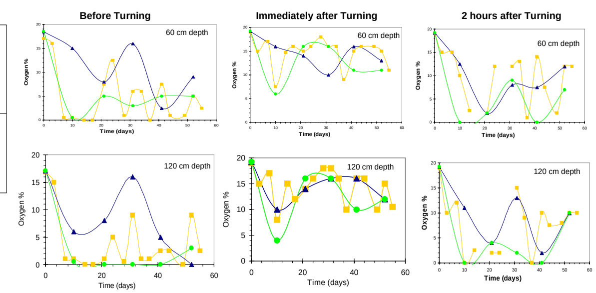

Figure 4. Oxygen concentrations in composts before, immediately after, and 2 hours after turning.

A Windrow (1turn/3d) B Window (1turn/10d) C Pile (1turn/10d)

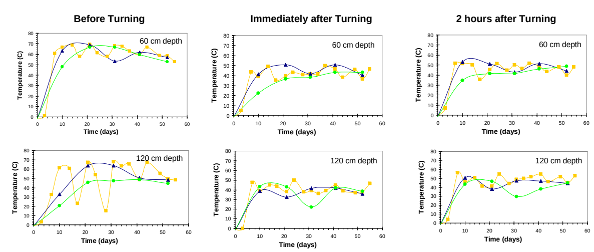

Figure 5. Temperatures in composts before, immediately after, and 2 hours after turning.

A Windrow (1turn/3d) B Window (1turn/10d) C Pile (1turn/10d)

CONCLUSIONS

• The turning frequencies and pile sizes used in this study did not appear to have a great effect on temperatures or oxygen concentrations during composting. Two hours after turning, similar oxygen concentrations and temperatures were observed in all treatments.

• Oxygen concentrations in windrows rose transiently after turning, but returned to preturn levels two hours.

• Neither moisture content, bulk density or volatile solids loss were affected by turning frequency or pile size.

• Infrequent turning (every 10 days) and large windrow sizes could be used to reduce the capital and operating costs associated with dairy manure composting.

• Future studies will replicate this experiment under summer conditions and use plant bioassays to determine the effects of these treatments on compost maturity.